Rediscovering Green Design

Engineers look to techniques of the past for cleanroom designs of the future

By WILLIAM TSCHUDI • Lawrence Berkeley National Laboratory • Berkeley, Calif.

Many engineers are focusing on "sustainable" design and jumping on the "green" bandwagon. Cleanroom designers are no different. They want to promote their services as being environmentally sensitive.

But I have a hard time imagining a green cleanroom. If you examine the makeup of a typical cleanroom, you find high-tech fans, filters, chillers, piping, pumps, special flooring, special wall surfaces, transformers, wiring, controls, etc. It is hard to think of these elements being green in terms of materials. Maybe we can work toward biodegradable HEPA filters, non-shedding-bamboo cleanroom flooring, or recyclable cleanroom fans (he says, tongue in cheek). Perhaps we can find new uses for used chillers or at least recycle a refrigerant. Or is a cleanroom green because of the way systems are put together?

A friend of mine recently told me he realized he was a green designer when someone pointed out that the use of free cooling was a green-design measure. My friend did not know he was part of this culture when he implemented free cooling on a cleanroom design more than 20 years ago, thinking it simply was good engineering practice.

This got me thinking that the way I was looking at green opportunities in cleanrooms was wrong. For example, cleanrooms frequently are rearranged. There is no reason why specialty components, such as raised floors, ceiling filters, etc., could not be reused. That would be good for the environment. Improvements in motor efficiency, variable-speed drives, and fan design that would enable configuration of more energy-efficient systems inevitably come along. Taking this a step further, Lawrence Berkeley National Laboratory's (LBNL's) energy benchmarking has identified numerous opportunities for improvement of cleanrooms energy performance. Minimizing energy use certainly is a green design goal. Now I see where a green designer fits in.

If we look at a cleanroom facility separately from a process housed inside, while trying to minimize energy use, we can begin to come up with generic features for cleanrooms that could be considered green. What are some of these? In addition to the free cooling I mentioned earlier, optimizing airflow represents a big opportunity. Cleanrooms rely on the movement of large volumes of air through high-efficiency filters to remove contaminants. LBNL's benchmarking saw large variations in recirculated-air-change rates, even though rooms operating at lower airflows were getting acceptable results along with huge energy savings. What is that old saying? Sometimes, less is more. Minimizing airflow makes good engineering sense and is something engineers have been doing for years.

Likewise, studies have shown that makeup- and exhaust-airflow optimization also represent a big opportunity—and a green measure. (Or is that just good engineering practice?) Once these parameters are optimized, systems that move the air can be designed. Here, it is largely about pressure drop or resistance to flow. A system with low pressure drop throughout enables the use of smaller fans using less power and allowing electrical distribution systems to be downsized. Then, within systems, fan and motor efficiencies come into play. The green designer and cleanroom owner should make system and component selections based on life-cycle-cost analysis. This will factor into an energy-cost

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component and lead to a green(er) selection. But isn't that what normal engineering practice is supposed to do? Designing a safe, functional system and considering all associated costs always has been part of the engineering design process. In the search for green-design measures, sometimes, sound practices from the past are rediscovered.

Another old tradition that has been lost and rediscovered is the art of commissioning. Once upon a time, quality assurance was more integral to building processes than it is today. With the fragmentation of building trades, elevation of "value engineering" as a means of cutting corners, and a shift from buildings as craft to commodity, quality and performance often are compromised. Ensuring that energy-using systems are operating per design intent (or even optimized beyond an original plan) can save significant amounts of energy and other resources.

Unlike ordinary buildings, cleanrooms certainly go through a rigorous certification process and other quality-assurance steps to ensure all systems are ready before startup. However, energy-oriented checks normally are not included routinely in this process at startup or during extended operation.

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